Description of the ER-2 Dropwindsonde System

The dropwindsonde to be deployed is a state of the art RD-93 model designed by the National Center for Atmospheric Research (NCAR) Atmospheric Technology Division (ATD) and currently produced in large quantity by Vaisala, Inc. The dropwindsonde was originally specified for the German prototype aircraft Strato-2C operating at 24 km. The RD-93 is a component of the NCAR Airborne Vertical Atmospheric Profiling System (AVAPS) and has been successfully used on several aircraft platforms including the U.S. Air Force WC-130s, the NCAR Electra, NASA DC-8, NOAA P-3's and G-IV Gulfstream. Details pertaining to the AVAPS characteristics and performance are described in Hock and Franklin (1999). A schematic diagram of the AVAPS is shown in Figure 1. The sonde weighs less than 400 g and measures 6.98 cm in diameter by 40.6 cm long. The main components include long-life lithium batteries, GPS antenna and receiver, Vaisala RS-90 humidity and temperature sensor module, piezoelectric pressure sensor, microprocessor card, radio transmitter (400-406 MHz band) and square-cone parachute.

An automatic version of this system, AAVAPS, was built in the summer of 2001 by NCAR ATD for integration onto the NASA ER-2. It is being used in the field for the first time during the Fourth NASA Convection and Moisture Experiment (CAMEX-4) in Jacksonville, Fl in August-September, 2001. Up to 50 dropwindsonde instruments will be deployed to sample the hurricane inner core environment.

The AAVAPS design permits simultaneous operation of up to 4 dropwindsondes (4-channel data system). Sampling rate is 0.5 sec for thermodynamic data and 1.0 sec for winds. Winds are computed using a fully code-correlating GPS receiver. The dropwindsonde sensor specifications are shown in Table 1 below. The thermodynamic sensors and GPS use technology which has been in high volume production for a number of years. From an ejection altitude of 24 km, the dropwindsonde requires about 22 minutes to descend to the ocean surface (static drop). Dynamic corrections for resolving fine-scale temperature and wind shear gradients are required for the initially large fallspeeds and low density at high altitudes. These corrections have been successfully applied to AVAPS data collected by the Hurricane Research Division (HRD) aircraft and are fully documented in Hock and Franklin (1999). Telemetry range of the dropwindsonde is 325 km which, given an ER-2 cruising speed of 210 m/s at altitude, is adequate to receive data throughout the complete descent profile of the sonde.

Table 1: NCAR AVAPS Dropwindsonde Sensor Specfications

Observable	Range	Accuracy	Resolution
Pressure	1080-20 hPa	+/- 1.0 hPa	0.1 hPa
Temperature	-90 to +60 C	+/- 0.2 C	0.1 C
Humidity	0-100%	+/- 7%	1.0%
Horiz. Wind	0-200 m/s	+/- 0.1 m/s	0.05 m/s

The ER-2 AAVAPS instrument dispensing system is designed to be semi-autonomous i.e. minimal pilot intervention will be required, and reflects an adaptation of the existing AVAPS hardware and software with modifications. Several operator interventions previously performed manually, including dropwindsonde initialization, GPS uplink and selection of a traffic-free transmission channel are now fully automated. The system is designed such that dropwindsonde channel selection will be transparent to the pilot (i.e. available channels are automatically monitored and allocated by the aircraft data system), reducing pilot workload to the level of a simple "push button for release" concept. Separate pilot alert indications will be provided for instruments that fail to transmit data after release, an instrument that fails to eject from the dispenser, and instruments still airborne.

The aircraft data system consists of a telemetry chassis which houses the power interface, telemetry receiver modules (one for each channel), Pentium 333 MHz personal computer, GPS receiver, spectrum analyzer, sonde launcher interface and pilot control interface. All electronics and hardware communicate via standard RS-232 connectors and are housed in an N_2 - pressurized, heated vessel adjacent to the launch dispenser. Ejection of sondes from each launch tube will be accomplished by using a coil spring. Sondes are retained against this spring pressure by a small retainer clip, which is released by activation of a solenoid. Figure 2 illustrates the design of the launch tube, the "gun barrel" design of the multi-tube dispenser and integrated hardware pressure cannister. All equipment is mounted in the centerline fuel pod beneath the belly of the ER-2 with the open ends of the launch tubes directed toward the aft portion of the pod.

All data telemetered by the dropwindsondes during descent are received on board the ER-2 and will be stored during flight. Data download after landing is accomplished by PC laptop interface to the hardware rack. The laptop is also used to interrogate the system during pre-flight, in order to check the function of all system components. In addition, each

sonde will be carefully pre-tested on the ground and certified for flight using a separate AVAPS control rack. Quality control of dropwindsonde data is accomplished post-launch using automated NCAR ATD software called Aspen. This software passes the data through 22 different quality check algorithms and applies data limit checks, hydrostatic height adjustments, performs the dynamic corrections and presents data in both tabular and graphical form. The software user can also make subjective changes to the data, view multiple dropwindsonde data traces simultaneously and adjust the algorithm QC limits.